COMPLEX MATERIALS SCATTERING (CMS)

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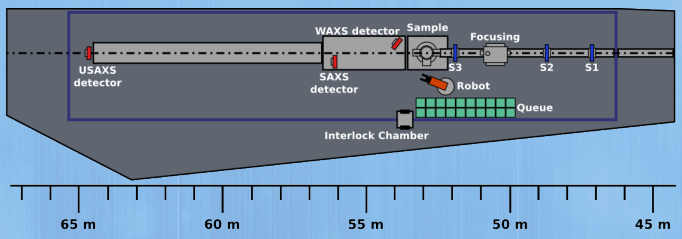
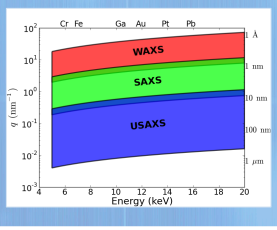
BROOKHAVEN NATIONAL LABORATORY

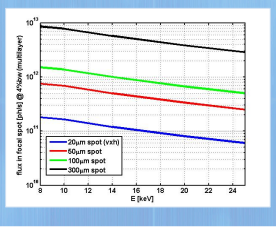
NATIONAL SYNCHROTRON LIGHT SOURCE II planned by Photon Sciences Directorate

TECHNIQUES AND CAPABILITIES

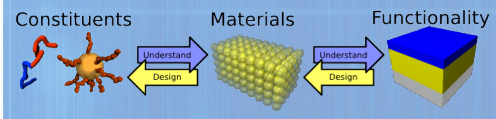
- Small- and wide-angle x-ray scattering on 3PW source, in transmission and reflection mode: **USAXS, SAXS, WAXS, GISAXS, GIXRD**
- **High-throughput** x-ray scattering for intelligent exploration of vast parameter spaces
- **Versatile** sample environment for stimuli-responsive and *in-situ* experiments
- **Broad *q*-range** (4×10^{-4} to 7.0 $Å^{-1}$) to study complex, hierarchical materials, including next-generation nanomaterials
- Microbeams and energy tuning (5 to 20 keV) for heterogeneous **sample mapping**

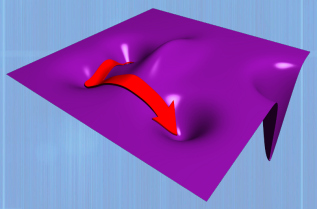


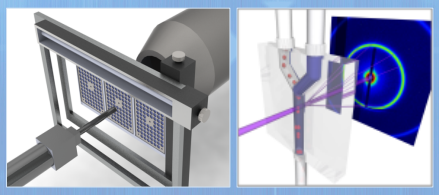




KEY CONCEPTS





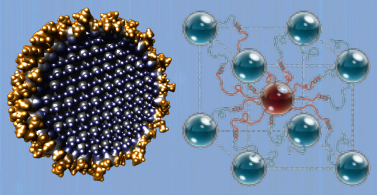


Rational materials design:
- New materials are hierarchical, nanoscale, and multi-component
- More sophisticated materials science requires *design*
- Need understanding at all length-scales

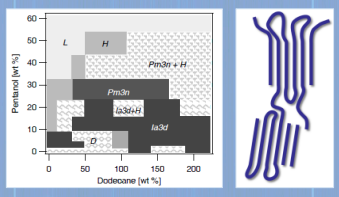
Non-equilibrium science:
- Path-dependent effects
- Processing history
- Stimuli/responsive
- Applied fields
- Engineering the energy landscape to *control order*

Automation and throughput:
- Robotic sample changer
- Explore vast parameter spaces using data feedback
- Integrated experimental controls (microfluidics, sample environments, mapping)

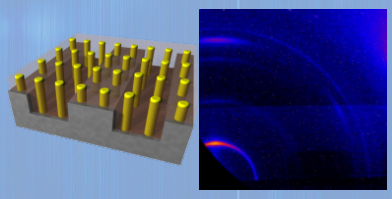
SELECTED APPLICATIONS



Synthesis: Using x-ray probes of structure to control reagent feeds, CMS will autonomously optimize synthesis (e.g. of nanoparticles)
Assembly: Tuning the self-assembly energy landscape with applied stimuli; understanding the resultant 3D hierarchical structures



Complexes and formulations: Massive parameter spaces will be explored to understand assembly and control formulation properties
Polymers: *In-situ* study of polymers under stress and flow will shed light on polymer crystallization



Devices: Studies of stimulated and direct self-assembly, e.g. in DNA lattices or block-copolymer nano-lithography, will pave the way for next-generation device architectures
Energy: High-performance materials for, e.g., organic solar cell, batteries, supercapacitors, fuel cells